

Submarine and Autonomous Vessel Proliferation: Implications for Future Strategic Stability at Sea

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EXECUTIVE SUMMARY

Conventional wisdom from the late Cold War onward suggests that the U.S. submarine force is virtually invulnerable to attack, particularly since the demise of the Soviet Union. U.S. nuclear force planning and a range of other Navy long-range procurement plans assume the safety of future SSBN and SSN operations and the relative absence of threats. This scoping study tests and challenges these assumptions by examining international trends in the proliferation of submarines and autonomous vessel technology. It begins by observing that undersea strategic stability during the Cold War relied on specific factors that may not be present in the future. The study then surveys the range of new countries and capabilities emerging in the 21st century undersea environment. It concludes by suggesting that undersea warfare is going to pose serious new challenges to the U.S. Navy, possibly putting its sea-based leg of the triad at risk as the number of operational boats declines, while also observing that overseas SSN operations will be complicated by changing conditions and ASW developments. Finally, Moltz offers several possible remedies: 1) revision of currently laissez-faire U.S. policies in the area of submarine export controls; 2) revised procurement and basing policies in regard to U.S. SSBNs to reduce emerging vulnerabilities; and 3) reconsideration of diesel/AIP boats as a supplement to U.S. SSN forces for enhanced ASW and for conducting certain domestic and overseas missions better suited to smaller, less costly, less vulnerable, and more nimble vessels.

INTRODUCTION

The United States has invested heavily in its ballistic missile submarine (SSBN) force, which now carries the bulk of the deployed U.S. nuclear arsenal and stands at the center of its current and future nuclear deterrent. The U.S. Navy also relies on its stealthy nuclear attack submarine (SSN) fleet to provide intelligence and to serve as a potent forward-deployed asset in enemy waters to engage threats far from U.S. shores. In the face of these strategies, growing global proliferation of advanced submarines, which are stealthier and carry better armaments than during the Cold War, is creating potential new risks to the security of U.S. SSBN and SSN operations. At the same time, emerging technologies in the field of unmanned surface and subsurface vessels raise the prospect of further complicating U.S. undersea operations, particularly in littoral waters. Ironically, many experts still discount the viability of hostile operations against U.S. SSNs and recent analysis of future U.S. SSBN requirements focuses almost exclusively on submarine costs and missile numbers, failing even to consider ASW as an issue.¹ Within the nuclear Navy, the topic of possible SSBN vulnerabilities is discussed privately by submariners (including in personal discussions with the author for this project), but is virtually a taboo subject in the Navy's printed media or speeches. This scoping study reviews the changing undersea threat environment and examines possible implications for U.S. Navy nuclear operations and for strategic stability more generally.

In order to accomplish this analysis, the report first reviews the factors that promoted strategic stability at sea during the Cold War. It then examines emerging undersea threats (in blue-, green-, and brown-water areas) and assesses how they might affect U.S. SSBN and SSN operations. It considers how new actors and new technologies, ranging from AIP boats, to new WMD-capable diesel submarines, to

¹ See, for example, Ronald O'Rourke, "Navy Ohio Replacement (SSBN[X]) Ballistic Missile Submarine Program: Background and Issues for Congress," Congressional Research Service, October 25, 2012. Surprisingly, while the report mentions the possibility of consolidating SSBNs to a single home port, and fewer than 12 submarines, there is no consideration of ASW threats to such a consolidated force as an issue to put before the U.S. Congress in its deliberations. Similarly, see John K. Warden, "After a New START," *Proceedings* (June 2012), which discusses the role of the need for a sea-based deterrent despite budget difficulties, but not possible concerns raised by future ASW threats.

midget submarines and semi-submersibles operated by smugglers or terrorists, to autonomous tracking vessels may expand Navy missions (and potential risks) in the future undersea domain. Finally, it concludes with an analysis of U.S. submarine procurement plans for the next 20 years, offering a critique of currently planned investments and some specific suggestions of alternative purchases that would—according to the findings of this research—more closely fit the future needs of the Navy and our nuclear deterrent forces while better addressing the challenges posed by emerging undersea technologies and their proliferation.

STRATEGIC STABILITY DURING THE COLD WAR

The Cold War argument on the *stabilizing* role of Cold War strategic submarines was based on three main assumptions: 1) that these vessels possessed a secure stand-off capability due to the long range of their weaponry; 2) that the submarines, due to their nuclear power and the limits of then-available anti-submarine warfare (ASW) technology, had the ability to hide anywhere in the world's oceans, thus rendering them virtually invulnerable to detection and attack; and 3) that no exports of this technology would ever be allowed because of the risks posed by the presence of multiple actors able both to deliver nuclear weapons at sea and possess full nuclear-fuel-cycle capabilities. But it is now worthwhile, years after the Cold War and with the benefit of declassified information, to reexamine these assumptions. If these factors are prerequisites for strategic stability at sea, it is important to assess whether these conditions are likely to be met under the influence of changing technological and geo-political conditions in the 21st century.

Long-Range Missiles

Today, many analysts assume that the superpowers relatively quickly acquired a reliable, second-strike capability with their submarines: that is, long-range ballistic missiles capable of being fired stealthily from virtually any ocean. This has become the first tenet of the Cold War strategic stability legacy at sea. In fact, however, the two superpowers experienced considerable difficulties during the Cold War in developing safe, effective, and stealthy strategic submarine delivery systems. This created possible instabilities during the nearly two-decade-long period before long-range missiles were

perfected. The process of transition has not even started in countries trying to station WMD at sea today, suggesting a possibly prolonged period of greater-than-normal risks.

Early U.S. Regulus-missile submarines, for example, could not fire their nuclear-armed cruise missiles without surfacing. Their weapons frequently suffered from reliability problems due to damage caused by environmental conditions in their on-deck storage compartments (which were outside the pressurized hull). Thus, they would likely have had to have been used early in a conflict to ensure flight worthiness. Similarly, first generation Soviet ballistic missiles could only be fired from a surfaced—and therefore vulnerable—position. U.S. Polaris missiles deployed during the 1960s improved the situation, but still had a range of only 1,200 miles against likely Soviet targets located at least 750 miles inland, thus sharply restricting their freedom of movement before launching. The follow-up version could fly only 2,500 miles.² Its successor, Poseidon, had a range of about 3,000 miles.³ The United States finally acquired truly long-range capability in the late 1970s with the 5,000-mile Trident I missile.⁴

These important details of the legacy of the Cold War at sea are too often forgotten in today's retelling of the story. Yet, as CDR (USN, ret.) Michael J. Dobbs summarizes: "Early SSBNs operated in a tactically dangerous environment. The short range of the first few generations of submarine-launched ballistic missiles (SLBMs) dictated that the boats patrol in close proximity to their intended targets."⁵ He notes that this "increased the threat of detection and antisubmarine warfare (ASW) attack."⁶

The Soviet Union experienced even greater delays in developing adequate stand-off range and had serious difficulties developing solid-fuel missiles for sea-based delivery, raising additional risks.⁷ The result was that many SSBNs had to cruise relatively close to enemy shores and, in the case of Soviet submarines, U.S. anti-

² George W. Baer, *The U.S. Navy, 1890-1990: One Hundred Years of Sea Power* (Stanford, CA: Stanford University Press, 1993), 258.

³ *Ibid.*, 434.

⁴ *Ibid.*

⁵ Commander (USN, ret.) Michael J. Dobbs, "The Incredible Shrinking SSBN(X)," *Proceedings* (June 2012), 35.

⁶ *Ibid.*

⁷ For much of the Cold War, the Soviets relied on liquid-fuel missiles, despite the risks such systems entailed, as seen in the Soviet *K-219* SSBN accident in 1986. In this incident, which took place during a patrol off the U.S. east coast, sea water leaked into a submarine-launched ballistic missile (SLBM) tube and

submarine warfare (ASW) defenses (buoys, ships, submarines, and aircraft) in order to be in a position to fire, thus raising incentives for early use in a crisis and creating instability. Only in the mid-1970s, when the Soviet Navy completed testing of the liquid-fuel SS-N-8 (or R-29), with a range of 4,850 miles, did it gain a true stand-off capability.⁸

Stealth, Invulnerability, and Anti-Submarine Warfare

A second key tenet of the undersea strategic stability argument was a belief in the invulnerability of submarines that were designated as “strategic.” For the two superpowers, this meant having dozens of stealthy, nuclear-powered submarines on constant deployment, making effective ASW against all of them virtually impossible. But even during the Cold War, various caveats must be made to sustain this argument. First, it took a number of years for either country’s nuclear submarines to develop the hydroacoustic profile that allowed true stealth to be enjoyed. The Soviet Union, in particular, suffered from a series of early problems in attempting to “quiet” its boats, leading to vulnerabilities to U.S. attack. Indeed, even later in the Cold War, the effectiveness of U.S. ASW through various means of detection created conditions under which Soviet SSBN commanders could not be confident in their ability to avoid destruction by the U.S. Navy. The Soviet development of the “bastioning” strategy—i.e., an explicit rejection of blue-water SSBN operations during a crisis and a plan to fire from port instead—signified the *failure* of the Soviet Navy to accomplish its goal of SSBN invulnerability.

Given these ASW risks, part of the prerequisite for invulnerability also rested on the large number of SSBNs fielded by both sides. At the height of the Cold War, the United States operated 36 SSBNs out of a half-dozen locations, making the job of tracking them extremely difficult given the limits of available technology. The Soviet Union’s SSNs posed somewhat of a threat to U.S. forces, but overall they did not prove up to the task, contributing to relatively lesser vulnerability of the U.S. strategic submarine fleet during the Cold War.

In the emerging undersea environment, a larger number of countries will have minimal sea-based deterrents with as few as one boat at sea at any time, and often

mixed with rocket propellant, starting a fire that vented deadly fumes. The damaged and still-burning vessel was scuttled with its nuclear weapons and reactors aboard.

⁸ Pavel Podvig, ed., *Russian Strategic Nuclear Forces* (Cambridge, MA: MIT Press, 2001), 324-27.

operating out of only one location. ASW technology is also advancing and spreading. As Vice Admiral (USN) John Richardson and Lieutenant (USN) Joel Holwitt observe: “More than ever, it is easy to be ‘seen,’ which can lead to being targeted and, increasingly hit.”⁹ Even the United States will be at greater risk in the future, particularly given the fact that it has already reduced its SSBN bases to only two and, in the future, may have as few as one platform at sea in each fleet at any given time. Particularly in the presence of emerging autonomous-tracking technologies, some of which are likely to be widely available within the next 20 years, these conditions raise the prospects for successful ASW against U.S. forces.

Exports and the Nuclear Fuel Cycle

During the Cold War, the prospect that either side would export technologies for strategic submarines or other ASW technology was remote. In fact, neither side exported its most advanced submarines or protected materials and technologies associated with their nuclear fuel cycle, nor shared its ASW equipment and know-how. Thus, while the United States sold a large number of surplus World War II submarines, the U.S. government implemented strict export controls over nuclear submarine technology, dismantled those it took out of service, and kept its ASW techniques secret. Although the United States considered providing nuclear submarine technology to the Netherlands, Canada, and France in the late 1950s during the Eisenhower administration,¹⁰ these offers were eventually withdrawn. Subsequent U.S. presidents prevented American shipyards from exporting nuclear submarines and related technologies. The one exception was America’s special relationship with the United Kingdom, which received U.S. naval nuclear reactors, submarine design information, and nuclear delivery systems.¹¹

The Soviet Union also instituted a ban on exports of nuclear submarines covering both SSBNs and SSNs with one exception mentioned below. Moscow continued to build and export conventional submarines throughout the Cold War, but most of the vessels sold or provided in military assistance deals abroad consisted of small, coastal “patrol”

⁹ Vice Admiral John M. Richardson and Lieutenant Joel Ira Holwitt, “Preparing for Today’s Undersea Warfare,” *Proceedings* (June 2012), 16.

¹⁰ John Newhouse, *War and Peace in the Nuclear Age* (New York: Alfred A. Knopf, 1989), 135; also Norman Friedman, *U.S. Submarines since 1945* (Annapolis, MD: U.S. Naval Institute, 1994), 127.

submarines, including those of the Tango, Foxtrot, and early Kilo classes, which were easily outrun and carried few advanced weapons.¹² Moreover, with the exception of China in the 1950s,¹³ the Russians generally did not provide production technology and refrained from offering sophisticated offensive systems. Finally, not one country with deployed nuclear weapons received Soviet submarines and no SSBN technology was transferred, nor was there joint ASW training or patrols.

Only very late in the Cold War did the Soviet Union transfer the only nuclear submarine during this period to be exported to another country, a Charlie-class SSN, which it leased to India in 1988-91. While this deal marked a new precedent, a 30-man Soviet engineering crew exclusively staffed and operated the reactor compartment, and the vessel was returned to Russia in 1991. Thus, it was more of an extended Indian “home porting” of this Soviet vessel than an actual “export.”

Notably, U.S. and Soviet restraint in exporting nuclear submarine technology occurred despite the existence of a loophole in the 1968 nuclear Non-Proliferation Treaty (NPT) that allowed countries to export nuclear submarines and their associated materials (including HEU fuel) and technologies, even to non-nuclear weapon states. The reason for this loophole stemmed from the complex politics of the NPT’s negotiation. At the time, several Western European countries had opposed further limits on their nuclear programs and had argued successfully to keep nuclear submarines and naval nuclear propulsion out of the NPT entirely.¹⁴ The strongest proponents of the exemption—the Netherlands and Italy—eventually chose not to pursue these options while Japan and Germany built and experimented with nuclear-powered surface ships for possible commercial use as cargo carriers.¹⁵ But, due to high costs and technical problems, both

¹¹ See Friedman, *U.S. Submarines since 1945*; Robert Green, “Conventionally-Armed UK Trident?” *Disarmament Diplomacy* (April 2001), 2-7; and Capt. Richard Sharpe, ed., *Jane’s Fighting Ships, 1992-93* (London: Jane’s Information Group Ltd., 1992), 689-90.

¹² Jan Breemer, “Appendix II: Soviet transfers of submarines abroad 1945-1988,” in *Soviet Submarines: Design, Development, and Tactics* (Coulson, England: Jane’s Information Group, 1989), 172-73. Countries receiving Soviet diesel submarines included Albania, Algeria, Bulgaria, China (before the Sino-Soviet split), Cuba, Egypt, India, Indonesia, Libya, North Korea, Poland, Romania, and Syria.

¹³ John Wilson Lewis and Xue Litai, *China’s Strategic Seapower: The Politics of Force Modernization in the Nuclear Age* (Stanford, CA: Stanford University Press, 1994), 48.

¹⁴ David Fischer, *History of the International Atomic Energy Agency: The First Forty Years* (Vienna: IAEA, 1997), 272.

¹⁵ The United States built the first nuclear-powered merchant ship, the *Savannah*, which operated (mostly as a publicity vessel for the “Atoms for Peace” program) until 1971.

Japan and Germany shut down these programs.¹⁶ Today, the NPT continues to allow states to produce nuclear submarines domestically and to purchase them internationally, as long as International Atomic Energy Agency (IAEA) safeguards accompany the HEU fuel during the transfer.¹⁷ Once the fuel is on site and moved to the military propulsion program, however, IAEA safeguards are removed. This poses new risks, as a variety of countries are now seeking a full fuel cycle, in some cases through the development of a nuclear propulsion program.

THE CHANGING UNDERSEA ENVIRONMENT IN THE 21ST CENTURY

The end of the Cold War had some obvious and initially positive effects on U.S. naval security. The overall number of Russian submarines active in the world's oceans dropped exponentially after 1991, when large numbers of strategic and non-strategic submarines were decommissioned due to lack of funding for their crews, operations, and required maintenance. Many other countries also slowed their procurement programs in response to the Cold War's end, at least initially. Indeed, one leading U.S. defense analyst argued smugly in 2003 that U.S. naval advantages so grossly outweigh the capabilities of other states that it need not worry about emerging submarine powers, concluding: "...all other nations have conceded the seas to the United States."¹⁸

But regional tensions have flared in various parts of the world since 1991, driving procurement behavior by several sizable and rising navies. Linked to what Owen Cote and Harvey Sapolsky called "export or die imperatives" facing a variety of post-Cold War defense manufacturers both in the West and in Russia,¹⁹ a steady proliferation of submarines began, boosted by new missile technologies also offered by certain suppliers. Compounding the problem was the fact that many of these submarine purchasers (Pakistan, India, Israel, and China) were in regions of concern and already possessed WMD. Others (such as Brazil) saw new submarine acquisition as a means to develop a

¹⁶ In Japan's case, for example, their nuclear ship had frequent problems. At one point, it had to be towed back to port from the middle of Pacific Ocean due to a reactor failure. Author's interview with senior Japanese diplomat knowledgeable about the program, February 14, 2002, in Monterey, California.

¹⁷ See James Clay Moltz, "Closing the NPT Loophole on Exports of Naval Propulsion Reactors," *The Nonproliferation Review* 6 (Fall 1998), 108-114.

¹⁸ Gregg Easterbrook, "Out on the Edge: American Power Moves Beyond the Mere Super," in the "Week in Review," *New York Times*, April 27, 2003, 1.

¹⁹ Owen Cote and Harvey Sapolsky, "Antisubmarine Warfare after the Cold War," conference report in the MIT Security Studies Conference Series, June 1997.

full nuclear fuel cycle, giving them access to HEU and possibly encouraging other countries (like Iran) to do likewise.

If we add the problem of autonomous vessel developments and the possible deployment by multiple countries of long-duration unmanned tracking vessels for ASW missions, the equation only worsens. As Captain (USN, ret.) Wayne Hughes observes: "...we may be on the leading edge of a new age in tactics. Call it the 'age of robotics.' Unpeopled air, surface, and subsurface vehicles have a brilliant, if disconcerting, future in warfare."²⁰

While many policy analysts are still thinking about the last "war" at sea (involving two major powers with similar types of arms) the future may look very different. As Hughes continues: "The revolution will be [one of] uninhibited robots that search and shoot under amazing modes of self-control."²¹

Interestingly, given pledges by many governments against the proliferation of WMD delivery systems, state perspectives on undersea technology proliferation can at best be described as "subjective." France has made direct sales of advanced submarines to nuclear-armed countries, even transferring whole production lines and designs, apparently discounting any possible threats these exports might cause. Russia continues to be an active exporter of finished diesel submarines and is now providing nuclear reactor and submarine-design technology to China and India. In the Middle East and elsewhere, Germany remains a major submarine exporter, despite the WMD possession of at least one of its clients. Thus, current major power policies (including those of the United States) seem to accept the Cold War premise that—in the right hands—new submarines are safe, or at least not an unduly negative influence on regional security.

But emerging developments suggest that future submarine rivalries could bring out some of the worst characteristics of the U.S.-Soviet period, as well as some new and even more dangerous ones. To better understand actual trends, this scoping study next takes a closer look at international submarine proliferation by dividing it into its two main categories: diesel/AIP submarines and nuclear boats. It then turns to the vexing problem of the emerging ASW threat posed by unmanned surface and sub-surface vessels.

²⁰ Captain (USN, ret.) Wayne P. Hughes, Jr., *Fleet Tactics and Coastal Combat*, 2nd edition (Annapolis, MD: Naval Institute Press, 2000), 3.

²¹ *Ibid.*, 5.

Diesel and AIP Submarine Proliferation

Sales of diesel and planned AIP submarines and, in some cases, complete production technology, are being undertaken by a number of large producers: Germany's Howaldtswerke Deutsche Werft (HDW), France's Direction des Constructions Navales (DCN),²² Sweden's Kockums (now owned by HDW), South Korea's Daewoo, and Russia's Rubin Design Bureau.²³ According to industry sources, some 150 submarines are currently on order for delivery by 2021.²⁴

Among these producers, France is arguably the most active exporter of diesel boats and one that has often provided production technology to sweeten deals with submarine purchasers who want to become producers themselves. Of greatest concern, France has provided Agosta-class diesel boats and production technology to Pakistan, despite Pakistan's refusal to join the NPT and terrorist attacks that killed a number of French engineers working in the country. India's Defence Ministry reached a co-production deal for six advanced French Scorpene-class diesel submarines, all of which are being built in India, with two being equipped with AIP technology.²⁵ More submarines may be added with both AIP and land-attack-capable missile tubes.²⁶ In addition, France's exports may be creating a secondary market. Pakistan reportedly offered to sell Pakistani-produced Agosta-class submarines to Saudi Arabia,²⁷ a country suspected of having its own nuclear ambitions. Such future transfers could stimulate proliferation tensions in the Persian Gulf, where Iran already has three Russian-provided Kilo-class submarines and might eventually desire to deploy WMD at sea.

Under the past three U.S. administrations, Washington has failed to protest Germany's provision of four Dolphin-class submarines to Israel, which the Israeli Navy is widely believed to have fitted with nuclear-tipped cruise missiles.²⁸ Given Israel's

²² DCN is a state-controlled concern that manages all French submarine construction and includes activities at several shipyards.

²³ The Dutch producer RDM Submarines and British Vickers Shipbuilding & Engineering, Ltd., have also constructed diesel boats in the past, but have no current orders. Several other small producers could become active exporters in the future.

²⁴ "Countries Modernizing Fleets," *Energy Weekly News*, June 24, 2011.

²⁵ Rajat Pandit, "With Eye on China and Pakistan, India to Revamp Submarine Fleet," *Economic Times* (New Delhi), December 30, 2011.

²⁶ *Ibid.*

²⁷ Syed Saleem Shahzad, "Pakistan on Military Sales Offensive," *Asia Times*, June 13, 2001; also, Intelligence Online (Paris), October 31, 2003, <http://www.intelligenceonline.fr/>.

²⁸ Associated Press, "Israel: Submarine Joins Growing Arsenal," *Los Angeles Times*, May 4, 2012.

location and the ample evidence of terrorist organizations with experience in carrying out suicide bombings and other attacks in Israeli cities, the presence of nuclear weapons on vessels in Israeli harbors is a reason for serious concern.²⁹ These submarines could be vulnerable when surfaced and during ingress and egress activities, where preventing unexpected attacks from the sea (including by divers and fast, maneuverable boats) is considerably more difficult than safeguarding nuclear weapons on land.³⁰

Germany has recently made several potentially destabilizing sales, including a recent agreement to provide two Type 209 attack submarines to the new government in Egypt led by the Muslim Brotherhood.³¹ Given its worsening relations with Israel, this sale could be the harbinger of a tenser naval environment in the waters surrounding the Middle East.

In some cases, these proliferated submarines might be used against U.S. naval assets. As one U.S. naval officer laments of the Type 209 submarines produced by Germany's HDW: "The most popular submarine export of the 1990s, more than 50 Type 209s were sold to 12 countries."³² The major threat is to surface ships and submarines. But this situation may change with the emergence of new clients with WMD capabilities. Small producers like South Korea have also begun creating a secondary market for German designs, recently offering two Type 1300 submarines—now built by Daewoo—to Indonesia, a country with growing naval interests.³³ HDW's new Type 212 submarines have an AIP capability, making these boats even stealthier. Any of these submarines could be modified for strategic missions, depending on the delivery systems provided (or installed domestically) and the WMD capabilities of the recipient state.

²⁹ Although Israel takes considerable precautions in protecting its coastline from hostile vessels, the chairman of the Knesset's Foreign Affairs and Defense Committee admitted that "The great threat from the sea is the global terrorist threat, and this is very dangerous." See his remarks in *The Jerusalem Post*, December 17, 2004; FBIS document GMP200441217000120.

³⁰ A 2005 court case in Turkey charged a Syrian Al Qaeda operative with planning to attack Israeli ships using speedboats loaded with explosives. Submarines could face similar threats either in Israel or in South Asian countries with active terrorist networks, such as India and Pakistan. See Amberin Zaman, "Syrian Charged in Plot to Attack Israeli Ships," August 12, 2005, <http://www.latimes.com/news/nationworld/world/la-fg-speedboat12aug12,1,1992843.story?ctrack=1&cset=true>

³¹ "Cairo to Acquire Two German-Made Submarines," *MENA Report*, September 4, 2012.

³² Lieutenant Commander (USN) Allen L. Edmiston, "Why We Need Nonnuclear Submarines," *Proceedings* (January 2004), 54.

³³ See report on the website of Indonesian Embassy to Finland, Monthly News Bulletin (September 2003), http://www.indonesian-embassy.fi/other9_2003.htm.

German and Swedish technologies, in particular, are leading the way toward the proliferation of stealthier submarines—offering existing technologies capable of three weeks submerged using AIP technology.³⁴ Russia's Rubin Shipyard is also now providing an AIP option on its Kilo-class and Amur-class submarines, promising to deliver up to 20 days submerged.³⁵ For states with WMD but without the resources to develop nuclear submarines, these technologies may give greater stealth capability and an incentive to put WMD at sea. Compared to nuclear submarines, their smaller size gives them access to littoral waters and their cost is approximately one-eighth as much.

As noted above, a perhaps more troubling aspect of a number of recent submarine deals is the willingness (even eagerness) of producers to provide cruise missile systems and advanced torpedoes as part of these transfers. Of greatest concern in regards to the WMD delivery threat are cruise missiles that can be fired from torpedo tubes. Such technologies have only been available on the international market for the past decade or so, although they were developed by the superpowers during the 1970s. While useful for deterrence, these weapons, of course, can also be used offensively. Torpedoes represent a threat to U.S. surface vessels and submarines alike. Unfortunately, a number of countries can provide these systems, mostly notably Russia and France.

Russia, for example, has provided 300-km range Klub S cruise missiles to India for its nine Kilo-class 877 EKM submarines,³⁶ which can be used to attack land- or sea-based targets and could be fitted with nuclear weapons. India has tested the 750-kilometer K-15 (formerly Sagarika) nuclear-capable ballistic missile as well, which is likely eventually to serve as the delivery system for its naval deterrent.³⁷ In response, Pakistan has claimed that it has also has plans for a sea-based nuclear deterrent, likely based on the Babur (Haft-7) cruise missile, although critics question whether the system has been tested at sea.³⁸ China has also deployed Klub missiles on its newest Kilo-class diesel

³⁴ David Eshel, Maxim Pyadushkin, and Sunho Beck, "New Submarines Use Advanced Technology to Improve Performance," *Aviation Week*, February 1, 2012.

³⁵ *Ibid.*

³⁶ Gordon Arthur, "Submarines Gain Buoyancy in Asia-Pacific Region," *Defence Review Asia*, April 27, 2012.

³⁷ Rajat Pandit, "India Quietly Gate Crashes Into Submarine-Launch Ballistic Missiles Club?" *The Times of India*, July 21, 2012.

³⁸ Usman Ansari, "Experts Wary of Pakistan Nuke Claims," *Defensenews.com*, May 26, 2012.

boats acquired from Russia.³⁹ Its Type 877 EKM submarines are capable of carrying 18 heavy torpedoes. Even states like Egypt, Turkey, and Chile have U.S.-provided Harpoon anti-ship cruise missiles capable of being fired from submarines;⁴⁰ these could be used for short-range land-attack missions as well, especially in a crisis.

While diesel AIP submarines with cruise missiles pose serious new concerns to opponents, they are unlikely to provide the invulnerable deterrent capabilities that their possessors seek—at least for a decade or more, while states seek longer-range missiles, better guidance packages, and greater stealth in their submarine operations. Instead, diesel AIP submarines are likely to suffer from significant vulnerabilities, recalling the period in U.S.-Soviet submarine history in the late 1950s and early 1960s.

In terms of stealth, these diesel and AIP boats will still need to rise to at least periscope depth for communication during crises and will have to snorkel in order to recharge their batteries. These requirements could lead to instability given the restricted areas near opponents' shores where they will have to operate in order to keep their short-range missiles at a lethal distance. While current ASW capabilities are still relatively underdeveloped in most of these regions, they will undoubtedly improve rapidly as states seek to counter opponents who are deploying WMD against their shores. These pressures may provide incentives for states to launch their missiles under pre-assigned orders or in "use them or lose them" scenarios, rather than encouraging states to hold submarines in reserve, as would be possible with longer-range missiles and submarines.

Despite these risks, current international export control regulations on submarine sales are very loose. The 1992 U.N. Arms Register has no limits on sales, but does require national declarations of exports of submarines larger than 750 tons in displacement or with missile/torpedoes with ranges of 25 km or more. However, these sales are lumped generically under the "warships" category and are not broken out separately as submarine sales. States in the Wassenaar Arrangement adopted rules in 2003 that require tougher reporting (although, again, not restrictions) of sales involving submarines with at least 150 tons displacement or any submarines with missiles/torpedoes with a range exceeding 25 km. The United States has called for new

³⁹ Arthur, "Submarines Gain Buoyancy in Asia-Pacific Region."

rules requiring declarations of sales of all submarines capable of carrying missiles/torpedoes.⁴¹ However, even if these guidelines are adopted, they will not constitute real limitations, only new reporting requirements.

Nuclear Submarine Proliferation

Although relatively few countries currently appear to be interested in acquiring nuclear-powered submarines, trends toward their continued steady proliferation and the first outright sales of nuclear-powered boats are also noticeable. While there are some compelling rationales for states to seek comparatively cheaper and safer diesel submarines, specific regional pressures, matters of national prestige, and arms race dynamics continue to drive a handful of states to seek nuclear submarines, whether through domestic production or imports. This raises the likelihood that additional states might acquire full-fuel-cycle nuclear capabilities, giving them the option of diverting HEU fuel to a bomb project.

Ironically, part of the reason for this new race to the sea among emerging and would-be nuclear powers may be the international demonstration effect. The most advanced navies in the world (U.S., French, and British) now operate *only* nuclear-powered submarines, sending a potent signal to other states that nuclear power is better. Moreover, the world's nuclear powers have steadily placed a higher and higher percentage of their nuclear weapons onto submarines. These goals were specifically embodied in the text of the U.S.-Russian START I agreement and is the clear direction of U.S. and, to a lesser extent, Russian nuclear forces in complying with the New START agreement. France has the vast majority of its nuclear weapons on submarines, and the United Kingdom has devoted all of its remaining nuclear weapons to its undersea forces.⁴² Meanwhile, China is gradually expanding its nuclear navy and becoming more active in using it. Beijing has begun sending its nuclear-powered Han-class SSNs into

⁴⁰ David Wood, "Threats emerge from below: thought to be a thing of the past, enemy submarines could be an obstacle to U.S. military might," *Navy Times*, September 27, 2004.

⁴¹ Darrell Spires, Bureau of Industry and Security, Department of Commerce, "Export Control Reform: Reshaping the Control Lists for Vessels of War and Submersibles," presentation at the 25th Annual Conference on Export Controls and Policy, Washington, DC, July 17-19, 2012.

⁴² Jonathan Marcus, "France's Enduring Nuclear Deterrent," BBC News, March 28, 2012; "Speech: Alistair Burt discusses the UK's nuclear stockpile on the BBC," Foreign and Commonwealth Office, United Kingdom, May 27, 2010.

Japanese territorial waters, stirring regional tensions.⁴³ China has now commissioned the first two of its Jin-class (Type-094) SSBNs and has begun testing its J-2 SLBM with an estimated range of 8,000 km.⁴⁴ China is expected to put its next-generation SSN (Type 095) into the water by 2015.⁴⁵ Thus, the message is clear: great powers have nuclear submarines and deploy nuclear weapons at sea.

This lesson has not been lost on a number of new nuclear powers, including Israel, Pakistan, and India. An Israeli commentator made the case a decade ago in an effort to push his country to put nuclear weapons on its German-provided diesel submarines: “The experience of the Cold War has taught that the only way to deal with a nuclear threat is by building a reliable and efficient deterrence capability,” specifically through the acquisition of “a submarine force armed with missiles.”⁴⁶ In a similar vein, Indian Admiral (ret.) L. Ramdas wrote in 1999, stimulating his country’s current move toward sea-based weapons, “The least vulnerable platform—both for detection and for destruction—is the missile-carrying submarine.”⁴⁷ Indeed, he cautioned India *not* to develop other forms of delivery, citing costs and broader security problems raised by air- and ground-based systems. Among this group of growing sea powers, Pakistan made an initial attempt at trying to slow this trend by urging India to agree to a ban on submarine-launched ballistic missiles.⁴⁸ However, there was no interest on India’s part in taking up this offer, as New Delhi believed that it had a naval advantage and a critical partner (Russia) willing and able to help it accomplish its goals.

But faulty assumptions among many would-be submarine powers about the relative ease of replicating Cold War conditions at sea taint the notion that simply putting weapons into submarines will be stabilizing. National intentions and doctrines matter, as

⁴³ Martin Fackler, “Japanese Pursuit of Chinese Sub Raises Tensions,” *Wall Street Journal*, November 15, 2004, A20.

⁴⁴ Arthur, “Submarines Gain Buoyancy in Asia-Pacific Region.”

⁴⁵ Hans M. Kristensen, “China’s Noisy Nuclear Submarines,” FAS Strategic Security Blog, November 21, 2009.

⁴⁶ Reuven Pedatzur, “Completing the Deterrence Triangle,” *Proliferation Brief* (Carnegie Endowment), Vol. 3, No. 18, 19 June 2000 (printed previously in Israel’s *Ha’aretz* newspaper, June 27, 2000).

⁴⁷ Admiral (ret.) L. Ramdas, “Arrogant nuclearism,” *Frontline* (Indian magazine), October 22, 1999, 105. Col. David Eshel (Israeli Defense Forces, ret.), “Israel’s Navy Gets New Strategic Deterrence Role,” *Proceedings* (March 2003), 68.

⁴⁸ Comments by Pakistani Ambassador to the United States Maleeha Lodhi in presentation on “Pakistan-United States Relations: The Regional and International Security Dimensions,” at the Center for Nonproliferation Studies, Monterey Institute of International Studies, Monterey, California, March 1, 2001.

do the nature of technologies they plan to deploy at sea and the dynamics of the physical and geo-political environments in which they will operate. As Iskander Rehman notes, “South Asia’s maritime environment is alarmingly unstructured,” due in part to Pakistan’s doctrine of “naval brinkmanship.”⁴⁹ Pakistani Navy Commander (ret.) Muhammad Azam Khan notes that India’s rapid advances at sea and overall conventional superiority have forced his country to maintain a nuclear “first-use option.”⁵⁰ Despite this problematic set of dynamics in terms of nuclear stability, both countries are now moving forward with naval deployment plans, and there is no U.S. policy opposing transfers by Russia, China, or France to the two potential combatants.

Although Argentina and rival Brazil engaged in a nuclear rapprochement over the last three decades and have apparently abandoned past plans for developing nuclear weapons, Brazil remains interested in developing a nuclear submarine, purportedly only for coastal defense. However, Brazil’s reluctance to grant IAEA officials full access to its nuclear facilities may be related to enrichment technology for this program and may indicate other reasons for completing the fuel cycle.⁵¹ In 2000, Brazilian naval officials began speaking openly of their plans for a nuclear submarine,⁵² and the Brazilian government allotted a new round of funding toward this long-standing project. In 2004, Brazilian Ambassador to the United States Roberto Abdenur responded to recent charges that his country is blocking IAEA access to certain nuclear facilities with the revealing comment, “Submarines are not subject to the safeguards regimen, that’s my view of things.”⁵³ Finally, in December 2008, France signed a deal with Brazilian President Luiz Inacio Lula da Silva to provide four French diesel submarines by 2017 and design information on a platform for Brazilian construction of a nuclear attack submarine by

⁴⁹ Iskander Rehman, “Drowning Stability: The Perils of Naval Nuclearization and Brinkmanship in the Indian Ocean,” *Naval War College Review* (Autumn 2012), 79.

⁵⁰ Commander (Pakistan Navy, ret.) Muhammad Azam Khan, “S-2: Options for the Pakistan Navy,” *Naval War College Review* (Summer 2010), 89.

⁵¹ Larry Rohter, “Brazil Resists Plan to Allow Spot Inspection of Nuclear Site,” *New York Times*, December 28, 2003, 4.

⁵² Mark Hibbs, “Brazil May Enrich to HEU for Submarine Reactor Fuel,” *Nuclear Fuel*, July 24, 2000, 7.

⁵³ Quoted in Larry Rohter, “Nuclear Secrets: If Brazil Wants to Scare the World, It’s Succeeding,” *New York Times*, October 31, 2004, “Week in Review,” 3.

2025.⁵⁴ Development of a full fuel cycle in Brazil for a submarine program, unfortunately, could stimulate other countries to pursue a similar route: either to a nuclear submarine or to a bomb.

The Brazilian precedent and the lack of opposition from major naval powers, including the United States, has stimulated copycat programs in other sensitive regions, such as the Middle East. In 2012, Iran's Deputy Commander for Technical Affairs Rear Admiral Abass Zamini shocked outside observers by announcing: "Right now, we are in the initial phases of manufacturing atomic submarines," adding that "using nuclear power to fuel submarines is among the civilian uses of...nuclear technology...[that] all countries are...entitled to."⁵⁵ Whether this is bluster or indeed the launching of a controversial effort to master the naval nuclear fuel cycle is still difficult to tell. But the trend is worrisome.

As the United States seeks to halt the international spread of weapons-grade materials through such efforts at the U.S.-sponsored U.N. Resolution 1540,⁵⁶ it has become more active in trying to promote measures aimed at preventing nuclear trafficking. One policy question that deserves greater attention is whether exports can be slowed or halted, or whether proliferation of strategic submarines must be viewed as "inevitable." In this regard, the evidence is contradictory. On the one hand, there are multiple producers of advanced diesel boats and there seems to be no international consensus against their proliferation. Second-hand submarines, moreover, are routinely sold on the international market. On the other hand, there are very few producers of nuclear submarines, suggesting that a supplier regime among the five current possessors might be developed and successfully applied, or at least that guidelines might be developed to slow their proliferation.

Today, the problem is complicated by the rapidly increasing number of likely actors, the greater prevalence of WMD, and the possible use of strategic submarines in close-in, regional (not global) conflicts. In this context, compared to the Cold War, the

⁵⁴ "Brazil: Navy to Inaugurate the First Phase of the Itaguaí Submarine Base This Month, *MENA Report*, November 8, 2012; also, Fabiana Frayssinet, "Brazil: Nuclear Subs to Defend Oil, Project Global Power," *Global Information Network* (New York), July 21, 2011.

⁵⁵ Quoted in Jay Solomon, "Iran Says It Plans Nuclear Submarine," *Wall Street Journal*, June 13, 2012, A10.

most *destabilizing* form of proliferation could be the import of a submarine by one of two regional rivals, which would provide its possessor with a technological step up and, for the regional adversary, a strong incentive to respond. Unlike with the superpowers, these new short-range submarines would be serving as surrogates for long-range submarines and ballistic missile programs. It may be easier to protect ground-based facilities from terrorists than naval bases, where divers or stealthy, fast attack vessels may make submarines vulnerable to the same type of suicide attacks that threaten U.S. and allied military forces, civilian transit systems and government buildings in the Middle East and South Asia today. Thus, the dynamics could be the opposite of those that characterized Cold War strategic stability at sea.

Emerging Autonomous Surface and Undersea Vessel Technology

The follow-the-leader trends in submarine development cannot be isolated from the ASW realm. Various technologies now under development pose the risk that ASW techniques may improve and spread significantly across the world's oceans over the next 20 to 30 years. One example is the project now being developed by the Defense Advanced Research Projects called the Continuous Trail Unmanned Vessel (ACTUV). The concept involves a diesel-powered surface vessel with an active sonar tracking device that could be cued to a submarine and operate autonomously to “achieve robust continuous track of the quietest submarine targets over their entire operating envelope.”⁵⁷ The ACTUV will use an active sonar device and surface communications technology and is expected to be “capable of missions spanning thousands of kilometers of range and months of endurance under a sparse remote supervisory control model.”⁵⁸ It could also be weaponized to destroy a target in a much shorter time, if commanded to do so.

Another concept is that of the large-diameter unmanned underwater vehicle proposed by some experts in the U.S. Navy. This technology could be deployed into critical areas of enemy sea traffic and wait until signaled, then fire weapons that would destroy ships with released mines or short-range torpedoes. As advocates argue, such

⁵⁶ For the full text of U.N. Resolution 1540, see the U.N. website, <http://www.un.org/News/Press/docs/2004/sc8076.doc.htm>.

⁵⁷ Scott Littlefield, “Anti-Submarine Warfare (ASW) Continuous Trail Unmanned Vessel (ACTUV),” Tactical Technology Office, DARPA, at: [http://www.darpa.mil/Our_Work/TTO/Programs/Anti-Submarine_Warfare_\(ASW\)_Continuous_Trail_Unmanned_Vessel_\(ACTUV\).aspx](http://www.darpa.mil/Our_Work/TTO/Programs/Anti-Submarine_Warfare_(ASW)_Continuous_Trail_Unmanned_Vessel_(ACTUV).aspx) (accessed September 12, 2012).

systems would be low cost and could “be deployed in sufficient numbers to close [a] choke point.”⁵⁹

The promise of this technology and its relatively uncomplicated nature suggests that the United States will not be alone in deploying such autonomous vessels when considering a 20-to-30 year time frame. Thus, such technologies could well be deployed against critical U.S. choke points, such as outside of the two (or possibly one) remaining U.S. SSBN bases. This raises obvious concerns about the future safety of transit operations in and out of port, particularly (but not exclusively) in a crisis. Indeed, as with the ACTUV system, there is no reason why such new vehicles could not be deployed off of trawlers or other commercial vessels that might be leased by an enemy or even, potentially, a terrorist organization.

As Owen Cote argues:

The most challenging scenario for the Navy is one where U.S. access to overseas bases is greatly reduced, and where the proliferation of relatively low cost and easy to use access denial weapons—such as modern diesel-electric submarines, modern anti-ship and anti-aircraft missiles, and naval mines—continues to grow.⁶⁰

These undersea platforms will become particularly threatening from an ASW context when such vessels add more capable and more accurate torpedoes to their arsenals. Commodore (Indian Navy, ret.) C.P. Srivastava observes that developments in wire-guided, heavyweight torpedoes “have not only been path breaking but also have significant latent potential, which is yet to be exploited.”⁶¹ He predicts that they could achieve “combat ranges of 100 km and endurance in the region of two hours.”⁶² These advances create new basing options as well. As Srivastava outlines their future trajectory: “Coupled with very advanced onboard signal processing and acoustic tell

⁵⁸ Ibid.

⁵⁹ Captain (USN) Scott Pratt and David E. Everhart, “Asymmetric and Affordable,” *Proceedings* (June 2012), 47.

⁶⁰ Owen R. Cote, Jr., *The Third Battle: Innovation in the U.S. Navy’s Silent Cold War Struggle with Soviet Submarines*, Newport Papers, No. 16, Naval War College, 2003.

⁶¹ Ibid.

⁶² Commodore (Indian Navy, ret.) C.P. Srivastava, “Business at Sea: The Two Capabilities That Can Transform the Way Submarines Do Trade at Sea are Revolutionary Developments in AIP Systems and Torpedo Technologies,” *SP’s Naval Forces* (October-November 2010), 2.

back, these would have the potential to be deployed either as ‘underwater drones’ with a warhead or as extended acoustic surveillance vehicles transferring real time data to the submarine....”⁶³

NEXT-GENERATION U.S. SUBMARINE PROCUREMENT PLANS

The focus of U.S. submarine procurement over the next several decades continues to be on large nuclear-powered vessels. This includes the SSBN(X) to replace the Ohio-class SSBN and Virginia-class SSN to replace the Los Angeles class attack submarine. Although more sophisticated than their predecessors and with some modifications to demands of the post-Cold War era and (in the Virginia class) an emphasis on littoral conflict, these purchases represent minor alterations of Cold War designs and emerge from status quo assumptions about the future ASW threat. They provide only limited ability to address an environment of increased transparency and vulnerability, engage well-armed small submersibles in littoral waters, or conduct support operations to combat threats in the area of homeland defense (such as drug smuggling by semi-submersibles, which could also become a conduit for illicit material smuggling). Evidence of the increasing use of such vessels against the West coast of the United States, at the very least, raises questions as to adequacy of the future submarine fleet to address such challenges.⁶⁴

In sum, U.S. procurement plans merit reconsideration for four main reasons: 1) the likely greater need to engage smaller and quieter undersea combatants in shallower waters compared to the Cold War; 2) the likely emergence of new ASW threats linked to autonomous vessel technology; 3) the vulnerabilities associated with low SSBN numbers in two decades operating from only two (or one) ports; and 4) the reduced need for large numbers of strategic missiles in an arms control environment likely to be situated in the realm of 100s rather than 1000s of nuclear warheads in the decades after 2020. These conditions suggest new needs for the Navy in the undersea domain. Yet Congressional and industry pressures, bureaucratic fear of challenging standard operating procedures, and a general disinclination within the Navy to grapple openly with the possible effects of

⁶³ *Ibid.*

⁶⁴ Paul A. Pavlock, “The Coming Maritime Insurgent Century,” *Proceedings* (December 2012).

changing conditions on the future submarine force have created what may be an inopportune plan for dealing with undersea threats in the middle of this century.

With costs for each SSBN(X) likely to rise to well over \$6 billion per boat, there will be strong pressure to reduce procurement. Some experts believe the number could drop to as low as eight total boats. As Congressional Research Service analyst Amy Woolf observes: “With few submarines in the fleet, the Navy would have to reduce the number of submarines on station, reduce the size of the patrol area, or possibly reduce the fleet to only one base in the Atlantic or the Pacific.”⁶⁵ Such a posture could pose very serious and unprecedented vulnerabilities to vessels transiting to sea.

Notably, there are solid historical precedents for these concerns. The 1983 Scowcroft Commission Report on U.S. strategic forces identified some of the same potential problems of excessive U.S. reliance on the submarine leg of the triad in stating: “a submarine force ultimately consisting solely of a relatively few large submarines at sea, each carrying on the order of 200 warheads, presents a small number of valuable targets to the Soviets.”⁶⁶ Rather than duplicate the Trident in any proposed replacement system, the commission recommended that the United States should “as much as possible, reduce the value of each platform and also present radically different problems to a Soviet attacker than does the Trident submarine force.” Unfortunately, the SSBN(X) fails to accomplish these goals, given the proliferation of highly capable SSKs, emerging autonomous systems, and developing Chinese, Russian, and Nth country undersea threats. As Norman Polmar writes of both the SSBN(X), which will combine elements of existing Ohio- and Virginia-class boats: “To employ the design concepts and components of these submarines ignores the probable developments in antisubmarine warfare (ASW) between now and 2080—the estimated service life of the SSBN(X), i.e., almost 70 years into the future.”⁶⁷

Indeed, the new dynamics of the 21st century undersea environment suggest that *new* criteria instead of maximizing missile upload capacity should drive our procurement

⁶⁵ Amy F. Woolf, “Modernizing the Triad on a Tight Budget,” *Arms Control Today* (January/February 2012), 12.

⁶⁶ Brent Scowcroft, et al., “Report of the President’s Commission on Strategic Forces,” The White House, April 1983, 11.

⁶⁷ Norman Polmar, “The Ohio Replacement Program: Is There an Alternative?” *Proceedings* (December 2012), 86.

decisions. Naval engineer Donald Kazimir argues, “With all the current global activity focused on building ultra-quiet, air-independent-propulsion diesel electric submarines, now is the time for the United States to create a truly stealth submarine.”⁶⁸ Alternatively, the Navy could instead decide that producing a larger number of smaller, cheaper vessels might address the vulnerability equation equally effectively. But the current trend toward very low numbers of SSNBs at two or one ports is likely to place the submarine leg of the triad into a more risky category than is desirable from the perspective of both strategic stability and national security. As Admiral Richardson and Lieutenant Holwitt argue about the Ohio-class replacement plan, “...we must get it right the first time for the critical and challenging mission it will execute.”⁶⁹ Similarly, although less urgent, is the planned reliance on large, Virginia-class SSNs for reconnaissance, forward presence, and anti-ship and anti-submarine engagement (as well as certain land-attack missions). This plan leaves gaps in the conduct of forward-based littoral operations and in potentially critical homeland defense missions along U.S. coastlines, as smuggling, illegal immigration, and terrorism become more common and possibly consequential in the coming decades. While currently the responsibility of the Coast Guard, the Navy has an important role to play and could develop capabilities through this process that could prove valuable in a future conflict overseas.

CONCLUSION: POLICY CONSIDERATIONS AND ISSUES FOR FURTHER RESEARCH

The trend of improved remote sensing and detection technology in the undersea environment over the next several decades suggests major new developments. Under these conditions, Cold War priorities to maximize carrying capacity and cruising range are likely to be less valuable and such platforms potentially vulnerable. Once located, such large platforms are extremely difficult to defend, especially if such identification takes place in shallow waters where speed may not be possible. As Capt. Hughes argues, in such encounters even “a markedly smaller force may have adequate net striking power to win.”⁷⁰

⁶⁸ Donald J. Kazimir, “Time for the Truly Stealth Submarine,” *Proceedings* (June 2008), 73.

⁶⁹ Richardson and Holwitt, “Preparing for Today’s Undersea Warfare,” 22.

⁷⁰ Hughes, *Fleet Tactics and Coastal Combat*, 274.

The evidence presented here shows that the proliferation of new strategic submarines and autonomous vessel technology poses new risks for U.S. submarine operations and sea-based deterrence than is reflected in current literature and in Navy plans. These vulnerabilities promise to worsen the threat of losing key platforms and increase risks of crisis instability in future undersea operations. Due to the involvement of new actors and new technologies—such as nuclear-capable cruise missiles and more stealthy but still essentially short-range diesel and AIP submarines—such proliferation will make encounters between hostile submarines more likely (by increasing the number of dyads), heighten the chances of accidents (including possible collisions involving nuclear-armed submarines), and stimulate regional arms races.

Given the changes likely in the emerging undersea threat environment, including the spread of destabilizing technologies and the expansion of the number of actors, it is advisable to consider some possible U.S. responses over the coming two to three decades, while there is still time to affect procurement cycles and future nuclear force posture. These remedies include several different recommendations spanning the Navy, the Department of Defense, and the State Department. Given the limited purview and scope of this study, they are not meant to be definitive or exclusive. Instead, these conclusions are meant to highlight potential concepts and themes that should be the subject of future research and further policy elaboration.⁷¹

First, in the area of naval nuclear policy, the Navy and the Defense Department should support greater study of the future ASW threat as it pertains to crafting a posture that retains U.S. SSBN invulnerability. If the SSBN(X) remains the platform of choice, possible remedies include the ability to operate boats from *multiple* domestic and overseas bases, whether by home-porting or not. This could include conducting crew rotations at up to a dozen U.S. or allied bases and varying operational deployment plans to raise the costs facing any adversary. Other options worth further consideration include development of smaller, more affordable nuclear-powered submarines with either reduced numbers of vertical tubes and/or vessels armed with nuclear-tipped, long-range cruise missiles that would enable more boats to be deployed, again increasing the complexity of any potentially crippling attack against the U.S. sea-based strategic

⁷¹ A draft agenda for a possible future workshop on these issues is attached to this study. See Appendix 1.

deterrent. Second, in the area of future attack submarines, the Navy and the Defense Department should reconsider the potential value of developing a small fleet of advanced, AIP-equipped diesel submarines for the Pacific and Atlantic regions. Such vessels are far cheaper than SSNs, more nimble in littoral operations, and yet capable of carrying highly potent missiles and torpedoes. These vessels could provide significant tracking and attack options for homeland defense while offering the Navy new options for forward-deployed operations against both SSNs and SSBNs of rising naval powers. Against China, for example, even a modest fleet of a dozen SSKs could provide considerable flexibility for littoral operations against ports and key egress points for major surface and sub-surface combatants, allowing more timely interception and confusing enemy planning and operations. While politically difficult, the cheapest and fastest route to acquire this technology could be via initial licensed production in the United States of foreign-design AIP boats such as from Germany or Japan. Working with key allies in this field could bring other benefits in terms of strengthened political-economic cooperation, joint submarine training (for SSKs), and future joint maritime operations.

Third, in terms of export controls and treaties, the State Department should consider certain specific changes to reduce the availability of advanced undersea technology on the international market. Beyond diplomacy aimed at eliminating the sale of SSKs known to be involved in the proliferation of WMD at sea, these efforts should tighten Wassenaar Arrangement, MTCR, and other relevant regimes to include critical submarine manufacturing technologies, ASW equipment, unmanned vessel technology, as well as torpedoes and short-range cruise missiles. At the same time, the United States should engage the small number of nuclear suppliers to close the NPT loophole on nuclear submarine exports. Just as Article V on peaceful nuclear explosions has become obsolete by informal convention by the late 20th century, so is it important that a policy denying transfers of technology aimed at nuclear submarine proliferation become the new rule for the 21st century.

Since the United States has no current plans to export submarines, there is a powerful logic for Washington to lead these control efforts, particularly as it seeks to implement parallel prohibitions on the spread of WMD and delivery systems around the world. New supplier arrangements could nip a number of emerging undersea risks in the

bud, while also protecting U.S. naval interests. A supplier regime for AIP technology might also be proposed, given the similarly small number of current producers. At the very least, sales might be limited to states without WMD capability—to prevent these submarines from serving as WMD delivery systems.

In conclusion, there is bad news and good news that must be grappled with in considering the emerging undersea warfare environment. The development and spread of technology presents options for new capabilities, but its proliferation to multiple states could create a situation that may eventually be harder to deal with than the single, large threat posed by the Soviet Union. Core themes of small size and larger numbers of systems (some of them unmanned) should be applied to future U.S. procurement to address these concerns. Greater efforts should be made to provide a mix of capabilities, leveraging autonomous, U.S. manned systems, and the capabilities of allies. Finally, U.S. diplomacy needs to become more active in the maritime domain in order to limit or prevent transfers (particularly by allies) that might eventually create undersea instability and heightened risks for U.S. forces.

The good news is that the United States remains the leader in most of these technologies. In addition, the acquisition of critical numbers of undersea manned and unmanned platforms by a number of potential adversaries remains a work in progress, granting time for U.S. forces and policies to react. But the current hubris of much U.S. planning suggests a failure to consider what could go wrong and, in some cases, very wrong in the future undersea world. At a time of U.S. leadership, assuming the best conditions and continued dominance via large undersea platforms is unwise. Instead, planning for the new challenges of the future should be done with a careful eye to the implications of a changing environment on U.S. operations and adjusting accordingly.

Appendix 1: Draft Workshop Agenda

Draft Agenda for a Workshop on **Submarine Proliferation, Emerging Technologies, and Future Strategic Stability at Sea**

Panel 1—Undersea Warfare: Reconsidering the Cold War Legacy

Overview: *This panel would set a baseline regarding undersea strategic stability during the Cold War and revisit specific conditions.*

Paper 1: “The Evolution of U.S. and Soviet Nuclear Submarines”

Paper 2: “The U.S.-Soviet Nuclear Weapons Deployments at Sea: Missiles and Warheads”

Paper 3: “Anti-Submarine Warfare during the Cold War”

Paper 3: “Changing Dynamics in Undersea Warfare: New Propulsion and Proliferation”

Panel 2—21st Century Submarine Proliferation

Overview: *This panel would discuss the current submarine marketplace and the international spread of platforms and weapons systems that might pose new threats to U.S. naval assets and facilities, as well as homeland defense.*

Paper 1: “Major Submarine Manufacturers and Export Trends”

Paper 2: “The Submarine Marketplace and Export Controls”

Paper 3: “Weapons Systems: New Missiles and Torpedoes”

Paper 4: “Unconventional Threats: Mini-Subs and Semi-Submersibles”

Panel 3—Autonomous Vessels and New Tracking Technologies

Overview: *This panel would examine emerging technologies in undersea and surfaced, unmanned vessels and various tracking technologies they may carry.*

Paper 1: “Developments in Autonomous Vessel Technology: Propulsion and Control Systems”

Paper 2: “Developments in Sea-Based Tracking Technologies: Sea-Based Systems

Paper 3: “Developments in Space- and Air-Based Tracking Technologies

Panel 4—Regional Contexts and National Strategies

Overview: *This panel will consider how the various technologies being developed for the future undersea domain are being married to specific national strategies and regional conflict environments, with particular consideration to their effects on U.S. naval operations and interests.*

Paper 1: “South Asia’s Undersea Developments”

Paper 2: “East Asia’s Undersea Developments”

Paper 3: “Middle Eastern Undersea Developments”

Paper 4: “Latin America’s Undersea Developments”

Panel 5—Revisiting U.S. Undersea Missions, Policies, and Procurement

Overview: *This panel will consider possible U.S. responses in the areas of operations, and submarine and autonomous vessel procurement, and export control policies.*

Paper 1: “SSNs and SSKs: New Missions and Options”

Paper 2: “SSBNs: Adjusting Requirements for Low Nuclear Numbers, New Threats, and Tight Budgets”

Paper 3: “U.S. Options for Improving Future ASW Training and Technologies”

Paper 4: “Possible Options for Strengthening International Export Controls on Submarines and ASW Technologies”